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TIME-STUDY AND TASK WORK

The primary object of scientific methods of management is to increase the productive capacity of a man or of a machine so as eventually to reduce the cost of the product to the consumer, and at the same time to increase the remuneration of the worker. This must be accomplished not by mere speeding up. It must be done by so arranging the work of the man as to eliminate unnecessary operations and waste of time, and by teaching him to perform each necessary operation in the best manner possible. It must be done by standardizing the running of the machine so as to fit each machine, as regards speed, accuracy, and constancy of operation, for the particular work it has to do.

The primary defect in the common types of management, however comprehensive they may be as regards organization, lies in the lack of application of scientific methods—the lack of methods which start at the bottom and thoroughly study each element in the process and then finally adopt a comprehensive plan of management which shall consider all the details and all the processes in the plan so as to produce one effective working combination, with the functions of each individual definitely designated.

This scientific method, the method of starting at the bottom, analyzing operations and standardizing all implements and machines, is difficult, it is slow, at the beginning it is costly. The problem to consider, then, is whether it will produce permanent

results that will pay in the long run better than day work or piece work or the premium plan as commonly employed.

Let us contrast for a moment the usual plan of fixing piece rates with the time-study method. Under the usual plan the foreman and superintendent get together, look over records and compare cost records of past performances, and then "guess" at the speed at which they think a man ought to do the job. In probably 99 cases out of 100 this guess will be wrong. If the rate which they conclude to fix is too low, the men will fail to earn usual day wages, and a strike is probable. If, as is more apt to be the case, the rates are too high, the men soon speed up so that they earn more than the management thinks they are entitled to. Immediately, the rate is cut, and the same operation is repeated. After one or two transactions of this kind, the men see that it is useless to try to earn a big wage, and when a new rate is set, they fix among themselves a definite output per day that will give them the highest wage that the management will pay. This is no mere theory, but is almost universal practice in piece-work shops.

How, then, do methods of scientific time-study for rate-fixing differ in principle from the ordinary plan of comparing cost records? The taking of records, the finding how long it has taken a man or a woman to do a certain piece of work is as old as the hills. Records of outputs on the various machines are given in every factory. The obtaining of such records, however, is not time-study. What then *is* time-study? Perhaps even some manufacturers do not know the difference between the ordinary way of finding how long it takes to do a piece of work, and time-study methods.

Let us take for an illustration the making and erecting of forms or molds for reinforced concrete buildings—the forms into which the semi-liquid concrete is poured in order to mold it to the proper dimensions for columns, beams, and slabs. The cost of forms is ordinarily figured either in terms of cubic yards of concrete or else in terms of square feet of surface area. Neither method is accurate. Take one of the simplest processes, the making-up of a side for a column form. The side of a column form consists simply of a panel made up of lengths of boards or planks with wooden cleats nailed across them at intervals. The cleats are placed upon the

work-bench, the boards or planks are placed across the cleats and nails are driven to fasten the cleats to the boards. Suppose in one case we have a form or panel for one side of a column 12 inches square. Suppose in another case, we have a similar form for a column 24 inches square. How shall we determine the comparative cost? Based on terms of the cubic yards of concrete in the column, the cost of the form for the 24-inch column should be four times as much as for the 12-inch. Based on surface area, the cost for the 24-inch should be twice that of the 12-inch. As a matter of fact, the time for making up of the 24-inch is only a little over one-third more than that of the 12-inch, and there is even less difference than this for the other operations of erecting and removing. Other parts of the work will be governed by still different ratios, so different, in fact, that it is absolutely impossible to figure accurate costs or set tasks by any system of cost records.

Time-study does it in this way: It takes the times of the elementary or unit operations of the man who makes the form. It finds out how long it takes him to place one cleat on the bench. It finds how long it takes to put a single board or plank on the bench. It finds out how long it takes him to drive one nail. It finds how long it takes to place the finished form on the pile. By taking a lot of observations on each unit and allowing a definite fixed percentage for the necessary rest, it is possible from such unit observations as these to determine the time, and therefore the cost for making up forms of any shape and size. If a certain form has more cleats, the unit time per cleat must simply be multiplied by the extra number; if more individual boards, the time per board by a different number of boards; if more nails, the time per nail by a different number of nails. By such processes as these it has been found possible to make up accurate tables for times and costs of forms of all lengths and sizes and shapes. By the other method of over-all times, a separate observation would have had to be made on every different length, width, and type and design. Records on one job would have been absolutely worthless for another or even for the same job under different conditions.

The same principles apply to other classes of work in the shop or in construction.

Time-study not only shows the time in which the work should be done, but it also assists in standardizing the methods and the implements. In connection with the making of forms, for example, it was found by time-study that a certain type of hammer was better than any other. It was found that a certain method of erecting the forms was considerably cheaper than any other plan. It was found that the number and size of nails, which ordinarily varied with each individual carpenter, could be fixed by definite standards to avoid waste in time and materials. It was found that there were certain methods of handling the lumber which were cheaper than any other way. It was shown by actual figures how much saving could be accomplished by furnishing laborers to do all of the heavy work so that the carpenters could stick to their job of carpentry.

This has been chosen as a typical case. It is *always* found, even in such simple work as carpentry, when time-studies are made and the work is thoroughly analyzed, that processes are improved and waste of time and of material is prevented.

Such studies are expensive. This is true, so far as the obtaining of the original data is concerned. It is to be remembered, however, that, once the data are obtained, the unit times and the standards are adapted, not only for that one piece of work, not only for that one locality, but for all processes, anywhere, involving the units observed. Ordinary over-all records taken in any one shop are quite useless for another shop. In time-study work the case is entirely different. We have instances of data taken in Philadelphia on the manufacture of one type of machinery being used in Boston for the manufacture of an entirely different type of machinery. While the work was different, the same units were used in the processes. The collection of such data in the various trades will therefore eventually prove of universal value.

The most important function of time-study, as has been implied, is setting tasks or fixing piece rates. Time-study is useful, also, for making more exact estimates. It is useful for standardizing implements and machines. It is useful for arranging a gang of men. In a recent civil service examination for a $4,000 engineering position, one of the questions asked for the general principle

involved in laying out a gang of men and horses for hauling earth from a bank to a distance of 1,000 feet. Out of 17 applicants, less than half appreciated the most elementary principle that the number of men loading carts must be governed by the time required for the carts to take the trip to and from the dump.

Many of those who have considered these methods in a superficial manner are doubtless saying to themselves: "This is all very well for some kinds of work; it is all right for simple work, such as form-making, but it cannot be done in the work with which I am connected." It would be almost amusing, if it were not so serious, to hear such a remark as this repeated over and over again by men in all classes of work with which we come in contact. The most practical answer lies in the fact that time-studies *have* been made and task work or scientific piece work actually has been introduced in so many classes of work that it is possible to state without question that the method is of practically universal application.

Not long ago, at a conference, a paper was read on the subject of the limitations of scientific management. The idea was expressed by the writer (who evidently had never come in close contact with the system) that scientific management was applicable to many classes of work, but that it was out of the question to apply task methods to the miscellaneous operations in the machine shop. Unfortunately for the person who read the paper, another speaker on the program was the president of a large machine shop, not merely manufacturing standard tools but making up miscellaneous orders. He stated that in his shop scientific methods of management had prevented failure during the hard times in 1907, had greatly increased output, and at the same time had reduced the number of men. If a machine shop manufacturing goods for special orders can have such complete records of time-study and unit times that task work is possible, one may be challenged to find *any* class of work involving labor either indoors or out-of-doors where tasks cannot be fixed by proper time-study.

In addition to the question as to the possibility of task work some persons may have raised in their minds the question of quality. Will quality be reduced by scientific task work? Experience in

scientific methods of management has shown positively not only that quality is not reduced, but that it is improved. As a matter of fact, tasks, if properly handled, provide a means for regulating, not merely the quantity, but also the quality of output. In many classes of work, the saving of material is of much greater importance than the saving in time. In such cases, the worker is paid a bonus, not simply for time, but for quality. In fact, the largest proportion of the bonus frequently is based on the saving of material.

So far have been discussed the general principles of time-study and the setting of tasks by scientific means. It is worth while to go somewhat farther into detail and consider the methods to be followed in making time-studies for task work.

There is one point, however, that I wish to make very clear indeed, because it is frequently a stumbling-block in the introduction of scientific methods of management. While time study is one of the fundamental principles involved in scientific management and while the other processes of management are centered to a considerable extent around the operation of tasks, in the sequence of the introduction of the new management, the setting of tasks is one of the last rather than the first of the operations to perform.

If a manufacturer wishes to take steps to increase his output, he naturally turns first to the consideration of the speed of the operative. How can I get more work out of my men? How can I determine in a scientific manner the amount of work they ought to do in a given time? How can I set the task or piece rate that will be fair? These are ultimate aims of a perfected organization, but instead of indicating the first thing to be done, they represent nearly the last. If you begin to set tasks without first getting your machines and your men and your methods of handling your materials into shape, you will fail absolutely in accomplishing anything but the most superficial results. It is just here that the scientific method differs most from the rule-of-thumb method.

The planning of the work is necessary in order that time shall not be wasted by the workers in ineffective effort. The routing must be carried to a high degree of excellence in order to distribute the materials properly and to permit the setting of individual

tasks. The worker must be trained in order to accomplish his task properly.

Turning to the matter of time-study when the plant is ready for it, the first thing that must be done, having obtained the necessary stop-watch and blanks for recording observations, is to analyze the operations. A decision must be made as to the elements or units into which each operation must be divided. In the case of form-making, for example, the units were placing cleat, placing board, driving nail, placing form on pile, together with certain others of less importance not mentioned. The sequence of operations must be determined so that the times can be readily entered. The time-study man must really learn each trade he observes. Preferably he should be chosen from the plant organization, since it is of much advantage for him to be familiar with the processes. On the other hand, a really expert time-study man, because of his power of analysis and of seeing the operations that are taking place, can handle any kind of work and in a very short time will know more of details than the manufacturer himself, simply because it is his job to watch each individual operation.

Standardizations of implements and machines must proceed hand in hand with the time-study. For example, even in such simple work as handling earth, the proper capacity of the cart or wheelbarrow must be determined, the size of shovel fixed, and so on. As a matter of fact, this standardization even in simple matters is much more intricate than one would think. In recent investigations of trenching made for the purpose of setting tasks, it was found that the ordinary classification of earth in terms of sand, loam, clay, etc., was absolutely worthless. The different classes so overlapped one another that no man could distinguish them accurately enough to fix a task. An entirely new plan had to be devised, and the secret was found to lie in considering the picking and the shoveling separately. The class of earth was determined by two sets of variables; one set based on the way in which the material picked and the other set on the load that could be put on the shovel.

With regard to the process to be followed in observations, the actual time-study is best made by taking a record of every opera-

tion which a man performs, including not merely the effective work, but the ineffective work and the lost time. The stop-watch is started, and the time in which the workman completes each operation, including the ineffective ones, is noted on the note sheets. Then, afterward, the results are studied and the operations tabulated and analyzed to see how much time is taken for the individual elements.

In making time-study, the selection of the operative to be observed is a very important point. Always select the best workers on the job for your principal observations. Even if the supply of labor is so small that it is impossible to limit the employment, in a particular branch, to men or women who are first-class operatives, and to relegate the other operatives to some of the places which they are better fitted to fill, the best workers should be selected because they work more steadily and their operations are more uniform. Also, the best workers are apt to use the best methods of doing the work and will adopt new suggestions more readily.

Observations taken on the best workers do not necessarily mean that these times can be used only for this class. A percentage has to be added to the net times in any case. By properly adjusting this percentage, the rates may be applied either to average workers working at a fair speed or to first-class workers.

It is usually a good plan to give the operative you observe a special incentive, such as an addition of 50 per cent to his or her pay on the day of the observation, as a compensation for the trouble you are making.

Having obtained the time of each of the units or elements by a large number of observations on the operatives selected, we are ready to make combinations of these unit times, so as to obtain the total required time for any operation containing these units. It is frequently convenient to make these combinations by means of a simple formula. For example, taking the making-up of the side of a column form, which has already been described, if we let

c = time placing cleat
b = time placing board
n = time driving nail
p = time lifting to pile,

then assuming 6 cleats, 2 boards, and 24 nails, the formula would be

$$6c+2b+24n+p$$

If seven cleats are used, the six in the first term would be changed to 7, if three boards are used, the $2b$ would be changed to $3b$ and so on. In practice, when task work is really started, these formulas are used to make up permanent tables, showing the total times for all the combinations that are apt to occur.

A percentage always must be added to the observed times before using them to set tasks, in order to provide for necessary lost time and delay occurring throughout the day. In certain kinds of work 30 per cent is a correct value for this. The per cent to add is governed by the character of the work and by the consideration of whether it involves machine or hand labor.

To fix the length of the task the time thus obtained may now be used directly. The general principle of task work is this: if the operative accomplishes the task in the time set, he is given his regular day wage for the period plus a substantial bonus. If he does not complete it in the given time, he receives his regular pay without the bonus. He never receives less than the day wage. If the data are to be used for setting scientific piece rates or premiums, the plan to be followed is somewhat different but the general principle is the same.

In determining the amount of bonus, it is necessary to bear in mind a fundamental law of Mr. Taylor's that "A man will not do a maximum day's work for an ordinary day's pay." In order to work at the best speed consistent with physical well-being, an operative must receive from 25 per cent to 75 per cent higher pay than his ordinary day wages.

To provide for required quality of the work, it is necessary, as has been said already, to adjust the bonus so that a man's payment will depend not simply upon output, but also on the quality of the product or the amount of material used.

In starting any form of piece work or task work an essential is to begin with one operative. See that this one is well started and making his or her bonus, before setting another similarly at work.

If a number of workers are started at the same time, one or more of them are certain to fall down and fail to accomplish their tasks in the set time, and this immediately gives an opportunity for dissatisfaction. The man or woman selected for the start should be one of the best in the department. He or she should be especially instructed just how to do the work, so that there can be no possible delay in handling the materials, and so that the operation will be accomplished with the fewest motions and by the best methods.

In beginning tasks on a certain line of work, it is frequently advisable to give a longer time than will be adopted permanently, provided, however, it is clearly stated to the operatives that this is simply temporary so as to enable them to become accustomed to the new methods, and provided it is also clearly stated that after a certain fixed period the rates will be changed to new, definitely stated figures. These permanent figures must be given out before tasks are begun. Never change this regular rate unless radical changes in methods or machinery are made by the management which reduce the amount of labor, and then only with the consent of the operatives.

As illustrations of the operation of task and bonus in practice, I may refer to one case of hand labor for girl operatives without machinery, where the reduction in cost averaged about 50 per cent during the first year after installation, while the girls accomplishing their tasks earned 40 per cent more than previously. In another case of two men operating a machine, the reduction in cost was about 35 per cent, notwithstanding a wage increase for tasks accomplished of 40 per cent. In form-making on construction it was found possible to reduce costs practically one-half, at the same time paying the men a very satisfactory bonus.

In such out-of-doors work as trenching, costs may be reduced say from 30 per cent to 70 per cent below average figures, according to the character of the work. For instance, such work as backfilling, when done by the day, gives a special opportunity for loafing on the part of the men, particularly where the gang is so small that a foreman is not assigned solely to each backfill job.

In many classes of machine work the increase in output is very large because of the standardization of the machine. In

certain government work, for example, such improvement increased the output over $2\frac{1}{2}$ times. In cases of which we have record, not merely was the labor cost substantially reduced, but the cost of the material was reduced by as much as half, chiefly by the thorough planning and routing of the materials for each piece of work.

In considering such increases in output and reduction in cost as these it must be borne in mind very distinctly that the saving is not accomplished by mere speeding up. In form-making, for example, it is due in large measure to the use of unskilled in place of skilled labor for handling the materials; to the layout of each form by sketches carefully prepared and lettered; to the use of proper tools; and to the arrangement of benches so as to make it as easy as possible for the men to do their work. It is such savings as these that reduce costs of production in a fundamental way, that benefit the workingman through increase of wages, and by reducing bother and friction. Such savings truly effect more economical production of wealth and must result in reducing costs to the consumer.

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